

UNCLASSIFIED

AD NUMBER	
AD066637	
CLASSIFICATION CHANGES	
TO:	unclassified
FROM:	confidential
LIMITATION CHANGES	
TO:	Approved for public release, distribution unlimited
FROM:	Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational Use; MAY 1955. Other requests shall be referred to Army Armament Research and Development Command, Picatinny Arsenal, NJ.
AUTHORITY	
ARRADCOM ltr 8 Jul 1982; ARRADCOM ltr 8 Jul 1982	

THIS PAGE IS UNCLASSIFIED

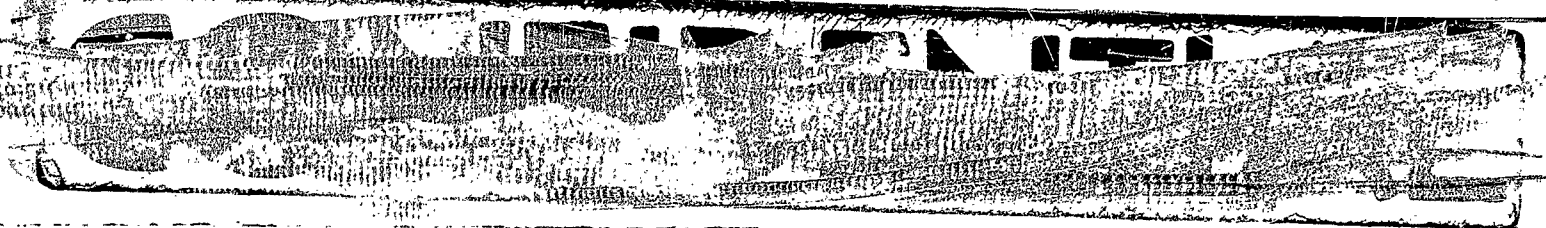
AD 66637

Armed Services Technical Information Agency

Reproduced by
DOCUMENT SERVICE CENTER
KNOTT BUILDING, DAYTON, 2, OHIO

Because of our limited supply, you are requested to
RETURN THIS COPY WHEN IT HAS SERVED YOUR PURPOSE
so that it may be made available to other requesters.
Your cooperation will be appreciated.

NOTICE: WHEN GOVERNMENT OR OTHER DRAWINGS, SPECIFICATIONS OR OTHER DATA ARE USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH A DEFINITELY RELATED GOVERNMENT PROCUREMENT OPERATION, THE U. S. GOVERNMENT THEREBY INCURS NO RESPONSIBILITY, NOR ANY OBLIGATION WHATSOEVER; AND THE FACT THAT THE GOVERNMENT MAY HAVE FORMULATED, FURNISHED, OR IN ANY WAY SUPPLIED THE SAID DRAWINGS, SPECIFICATIONS, OR OTHER DATA IS NOT TO BE REGARDED BY IMPLICATION OR OTHERWISE AS IN ANY MANNER LICENSING THE HOLDER OR ANY OTHER PERSON OR CORPORATION, OR CONVEYING ANY RIGHTS OR PERMISSION TO MANUFACTURE, USE OR SELL ANY PATENTED INVENTION THAT MAY IN ANY WAY BE RELATED THERETO.



**Best
Available
Copy**

FINAL REPORT
NN-F-6
Contract DAI-19-020-501-ORD-(P)-53
NATIONAL NORTHERN
West Hanover, Massachusetts

Confidential

NATIONAL NORTHERN
West Hanover, Massachusetts

205283

NN-F-6

DETERMINATION OF FREE-AIR BLAST OF
ONE-POUND HIGH EXPLOSIVE CYLINDERS

Contract DAI-19-020-501-ORD-(P)-53

FINAL REPORT

May 1955

Submitted by:

V. Philipchuk

Approved by:

C. M. Sauer, Jr.
Assistant Manager

Approved by:

S. J. Porter
Manager

NOTICE: This document contains information affecting the National Defense of the United States within the meaning of the Espionage Act, 50 U.S.C. 31 and 32 as amended. Its transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

Confidential

The Technical Division of National Fireworks Ordnance Corporation

AUG 9 1955

cy

02

55 AA

32863

Reg 1259

Confidential

2.

TEST AUTHORITY

Test requirements for free-air blast determinations on 210 one-pound explosive charges, supplied by Picatinny Arsenal, were outlined in Picatinny Arsenal letter ORDBB-TJ2; S. M. Adelman/mtb/5259, dated 1 December 1954. Testing was conducted under Contract DAI-19-020-501-ORD-(P)-53.

Confidential

55AA 32863

1.0 CHARGE DATA

1.1 The 210 charges submitted by Picatinny Arsenal consisted of groups of 30 each for 7 different explosives. Each group of 30 was comprised of 10 bare, 10 steel-cased, and 10 aluminum-cased charges.

1.2 Data on the test items were submitted by Picatinny Arsenal on Experimental Ammunition Data Cards or computed by National Northern as follows:

HE	HE wt.		HE Density		HE Volume (cc.)	HE Diameter (in.)	HE Height (in.)
	lbs.	grams	*N	**P. A.			
MOX-2B	1.02	463	2.03	2.10	228	1 7/8	5 1/16
SSB/K5	1.03	467	1.73	1.79	269	1 7/8	5 15/16
PBX	1.01	458	1.60	1.61	285	1 7/8	6 5/16
TNT	1.06	482	1.60	--	299	1 7/8	6 10/16
Torpex-2	1.08	491	1.79	--	273	1 7/8	6 1/16
HBX-1	1.03	467	1.70	--	273	1 7/8	6 1/16
HBX-6	1.05	476	1.75	--	272	1 7/8	6 1/32

* computed from volume in cylinders by National Northern

** pellet density reported by Picatinny Arsenal

1.3 The steel and aluminum cylinders all had a 1 7/8" I.D., a 2.0" O.D., and were closed at the base with a 1" thick plug pressed into the cylinder. Steel plugs were used for the steel-cased charges and aluminum plugs for the aluminum-cased charges. The "equivalent" (i.e., neglecting the base plug in these cases) charge-to-weight ratios of the test items were computed as follows:

Cylinder I. D. = 1.875 in.

Cylinder O. D. = 2.00 in.

Density of steel = 7.83

Density of aluminum = 2.71

<u>HE</u>	<u>HE Density</u>	<u>"Equivalent" Charge - to - Weight Ratios</u>		
		<u>Bare</u>	<u>Al</u>	<u>Steel</u>
MOX-2B	2.03	1.0	.84	.65
SSB/K-5	1.73	1.0	.82	.61
PBX	1.60	1.0	.81	.60
TNT	1.60	1.0	.81	.60
Torpex-2	1.79	1.0	.83	.62
HBX-1	1.70	1.0	.82	.61
HBX-6	1.75	1.0	.82	.62

2.0 STATIC TEST EQUIPMENT

Static tests of the subject charges were conducted at National's Halifax Range at the Free-Air Blast Site. This site consists of a quadinstrument arrangement for detecting blast from a single charge. Details of this site and the Semi-Confined Blast Site (used to evaluate HE blast having partial confinement) are the subject of a separate report which will be released by National to contracting agencies in the near future. The details and instrumentation on the Free-Air Blast Site are briefly as follows:

2.1 Charge. The charge is placed 9 ft. above ground level with its axis at a 45° angle.

2.2 Gauges. Four detectors are located, each in different quadrants, around the charge and at various distances from it. Each instrument is so placed

as to receive the free-air blast (incident) wave, i. e., no reinforcement from reflected or Mach waves. These four detectors are as follows:

- 2.2.1 **Pendulum Gauge.** Designed by National to record an integration of pressure-time, 290 lbs. in weight, 2 ft. square, and 3 ft. from the charge's center.
- 2.2.2 **Catenary Diaphragm.** Developed for use in high-explosive blast determinations to record pressure-time, side-on to the blast wave, and 6' 8" from the charge's center.
- 2.2.3 **Foilmeter.** National's modification of the Bikini Gauge used to record peak pressures, face-on to the blast front at 5 feet from the charge's center. Foil of .0025 in. S aluminum.
- 2.2.4 **5" N-T-C.** Designed by National as a possible means for correlating with aircraft damage beyond an over-kill area. This gauge is 5" in diameter, facing the charge, and has steel tubular compartments (T-C) 6" in length with .0025 in. S aluminum foil between compartments. Face of No. 1 compartment 6' from the charge's center.

2.3 **Booster.** All charges in this test were initiated by 25 gram tetryl pellets and No. 8 electric blasting caps placed at the open ends of the cylinders.

3.0 TEST RESULTS

3.1 Detailed recordings of the individual charges are listed in the enclosed Tables I - IV, incl., and are summarized as follows:

FREE-AIR BLAST10 Round Averages, 1# HE Charges

<u>HE</u>	<u>Pendulum (Degrees)</u>		<u>Al</u>	<u>Bare</u>	<u>Foillmeter</u>		<u>Al</u>
	<u>Bare</u>	<u>Steel</u>			<u>Steel</u>		
Torpex-2	16.4	19.6	17.7	8.8	8.7		8.9
HBX-6	17.9	19.4	18.8	8.1	8.8		8.2
SSB/K-5	17.0	18.3	17.7	7.9	9.1		8.8
HBX-1	17.3	18.1	17.8	8.2	7.9		8.5
PBX	13.6	14.5	14.3	8.1	7.8		8.0
TNT	13.8	14.9	14.9	7.6	6.8		7.7
MOX-2B	11.5	14.7	12.8	4.3	5.7		4.7

<u>HE</u>	<u>*Category, Δ psi</u>			<u>Bare</u>	<u>5" N T-C</u>		<u>Al</u>
	<u>Bare</u>	<u>Steel</u>	<u>Al</u>		<u>Steel</u>		
Torpex-2	25.0	24.7	24.8	6.6	3.7		4.5
HBX-6	24.4	24.2	25.3	6.3	3.6		5.2
SSB/K-5	24.7	24.2	24.5	6.0	3.6		5.2
HBX-1	23.7	23.6	24.4	5.7	3.7		4.7
PBX	23.2	22.4	23.2	4.7	3.3		3.6
TNT	22.3	21.3	21.9	4.7	2.7		3.1
MOX-2B	16.1	17.3	16.3	2.9	2.4		2.6

* 13 of 210 readings were not recorded because of instrument failure.

4.0 CONCLUSIONS

Only general conclusions may be drawn from the free-air blast test results since many variables entered into the program: explosive volume (HE weight held at 1.0 lb. nominal), confinement (c/w ratio), and the measurement of various blast parameters (impulse, peak, and compartment damage).

4.1 Torpex-2, HBX-6, SSB/KS, and HBX-1 were the highest free-air blast producers on all four blast recorders, with PBX, TNT, and MOX-2B following in that order.

4.2 The steel-cased charges produced the highest pendulum readings, with aluminum-cased and bare charges following in that order.

4.3 Only small differences in peak pressures were noted among bare, steel-, and aluminum-cased charges at the distances recorded: 5' for the foll-meter and 6' 8" for the catenary.

4.4 Since the four explosives previously mentioned, Torpex-2, HBX-6, SSB/KS, and HBX-1, were essentially alike in blast performance, the selection of the best filler to be used in this item would be determined probably by the fragmentation characteristics, i.e., fragment velocity and mass distributions.

5.0 DETAILED TEST DATA

5.1 Table 1. Free-Air Pendulum

Nominal HE wt.: 1.0 lb.

Range: Halifax

<u>HE</u>	<u>Case</u>	<u>Pendulum Readings (Degrees)</u>	<u>Average</u>
Torpex-2	Bare	14, 17, 17, 18, 18 1/2, 13, 15, 19, 16 1/2, 17 1/2	16.4
"	Steel	18 1/2, 19 1/2, 20, 19, 18 1/2, 17 1/2, 20, 22, 21, 20	19.6
"	Al	16 1/2, 19 1/2, 17, 20, 16 1/2, 16, 21, 15, 17 1/2, 19	17.7

Confidential

8.

<u>HE</u>	<u>Case</u>	<u>Pendulum Readings (Degrees)</u>	<u>Average</u>
HBX-6	Bare	22, 15 1/2, 14 1/2, 20 1/2, 19, 19, 19, 15 1/2, 15, 19	17.9
"	Steel	16 1/2, 16, 17, 18, 19, 19, 19 1/2, 21, 20, 22	19.4
"	Al	15, 17, 17, 20 1/2, 15, 21, 21, 21, 16 1/2, 24	18.8
SSB/K5	Bare	21, 18 1/2, 13 1/2, 13, 16, 14, 19, 19 1/2, 17 1/2, 17 1/2	17.0
"	Steel	19, 18, 15, 19, 18, 15 1/2, 20, 17, 20, 21	18.3
"	Al	17 1/2, 15 1/2, 15 1/2, 19, 19, 14, 16, 16 1/2, 21, 22 1/2	17.7
HBX-1	Bare	15, 16 1/2, 21, 17, 16 1/2, 17 1/2, 14 1/2, 19, 19, 17	17.3
"	Steel	16, 16 1/2, 16, 19, 17 1/2, 20, 17 1/2, 18 1/2, 18, 21 1/2	18.1
"	Al	17, 15 1/2, 15 1/2, 20, 15 1/2, 19, 19, 17 1/2, 18 1/2, 20 1/2	17.8
PBX	Bare	16 1/2, 12, 12, 14 1/2, 12 1/2, 12 1/2, 12 1/2, 14 1/2, 15, 14	13.6
"	Steel	12 1/2, 12 1/2, 14 1/2, 15 1/2, 13, 13, 14, 16 1/2, 17 1/2, 17	14.5
"	Al	13, 12, 14, 15, 13, 13, 13 1/2, 19, 16 1/2, 14	14.3
TNT	Bare	12, 13 1/2, 13, 14, 14, 13, 14, 16, 13, 15	13.8
"	Steel	14, 13, 14, 14, 14, 13, 14 1/2, 19 1/2, 19, 20	14.9
"	Al	17, 12, 14, 18, 11, 11, 18, 17 1/2, 12, 18 1/2	14.9
MOX-2B	Bare	10, 10 1/2, 10 1/2, 10 1/2, 13 1/2, 11, 12 1/2, 11 1/2, 12 1/2, 12	11.5
"	Steel	13 1/2, 14, 13 1/2, 16, 14, 14, 14 1/2, 15, 16 1/2, 16	14.7
"	Al	12, 13 1/2, 12 1/2, 11, 12, 13, 14 1/2, 14 1/2, 14, 12	12.8

5.2 Table II. Free-Air Foilmeter

Nominal HE wt.: 1.0 lb.

Range: Halifax

<u>HE</u>	<u>Case</u>	<u>Foilmeter Readings</u>	<u>Average</u>
Torpex-2	Bare	8, 9, 9, 9, 9, 9, 10, 8, 9, 9	8.8
"	Steel	8, 8, 8, 9, 9, 10, 9, 9, 9, 8	8.7
"	Al	8, 9, 9, 9, 9, 8, 9, 10, 9, 9	8.9
HBX-6	Bare	6, 8, 8, 8, 9, 9, 8, 8, 9	8.1
"	Steel	8, 9, 9, 8, 9, 9, 9, 9, 9	8.8

Confidential

<u>HE</u>	<u>Case</u>	<u>Foilmeter Readings</u>	<u>Average</u>
HBX-6	Al	8, 9, 7, 9, 9, 8, 7, 9, 7, 9	8.2
SSB/K5	Bare	7, 7, 7, 7, 8, 7, 8, 9, 9, 10	7.9
"	Steel	8, 10, 8, 9, 10, 8, 9, 9, 10, 10	9.1
"	Al	9, 9, 8, 8, 9, 9, 9, 9, 9, 9	8.8
HBX-1	Bare	8, 8, 4, 8, 9, 9, 9, 9, 9, 9	8.2
"	Steel	8, 8, 4, 8, 8, 8, 9, 9, 9, 8	7.9
"	Al	9, 7, 7, 9, 9, 8, 9, 10, 8, 9	8.5
PBX	Bare	6, 8, 9, 8, 7, 8, 9, 8, 9, 9	8.1
"	Steel	7, 6, 8, 8, 8, 8, 8, 8, 8, 9	7.8
"	Al	8, 7, 8, 7, 8, 7, 9, 9, 9, 8	8.0
TNT	Bare	7, 7, 8, 8, 7, 8, 8, 8, 7, 8	7.6
"	Steel	7, 6, 6, 6, 7, 6, 8, 8, 7, 7	6.8
"	Al	6, 7, 8, 7, 8, 8, 8, 8, 9, 8	7.7
MOX-2B	Bare	3, 1, 4, 3, 4, 4, 4, 6, 6, 8	4.3
"	Steel	6, 2, 5, 7, 4, 6, 7, 7, 5, 8	5.7
"	Al	5, 3, 5, 3, 4, 4, 4, 7, 5, 7	4.7

5.3 Table III. Free-Air Catenary

Nominal	HE wt.: 1.0 lb.	Range: Halifax	
<u>HE</u>	<u>Case</u>	<u>Catenary Readings (Δ PSI)</u>	<u>Average</u>
Torpex-2	Bare	22 1/2, 22 1/2, 25, 25, 27 1/2, 27 1/2, 25, --, 26, 24	25.0
"	Steel	22 1/2, 25, 22 1/2, 24, 27 1/2, 27 1/2, 25, --, 24, 24	24.7
"	Al	24, --, 24, 24, 27 1/2, 27 1/2, 25, --, 22 1/2, 24	24.8
HBX-6	Bare	22 1/2, 25, 25, 25, 25, 25, 25, 26, 22 1/2, 22 1/2	24.4
"	Steel	22 1/2, 25, 25, 25, 22 1/2, 25, 25, 25, 24, 22 1/2	24.2
"	Al	22 1/2, 25, 27 1/2, 25, 27 1/2, 25, 26, 25, 25, 24	25.3
SSB/K5	Bare	24, 22 1/2, 25, 24, 27 1/2, 25, 25, --, 25, 24	24.7
"	Steel	22 1/2, 22 1/2, 25, 25, 24, 25, 25, 24, 26, 22 1/2	24.2
"	Al	25, 22 1/2, 25, 25, 27 1/2, 25, 20, 25, 25, 25	24.5
HBX-1	Bare	--, --, 22 1/2, 24, 25, 24, 25, 22 1/2, 24, 22 1/2	23.7
"	Steel	22 1/2, --, 21, 25, 22 1/2, 25, 24, 25, --, --	23.6

<u>HE</u>	<u>Case</u>	<u>Catenary Readings (ΔPSI)</u>	<u>Average</u>
HBX-1	Al	22 1/2, --, 25, 22 1/2, 25, 25, 25, 25, 24, 24	24.4
FRX	Bare	22 1/2, 24, 20, 22 1/2, 22 1/2, 25, 25, 25, 22 1/2, 22 1/2	23.2
"	Steel	22 1/2, 22 1/2, 20, 20, 22 1/2, 25, 24, 24, 21, --	22.4
"	Al	--, 24, 20, 25, 25, 20, 25, 24, 23, 22 1/2	23.2
TNT	Bare	21, 21, 21, 22 1/2, 25, 22 1/2, 25, 20, 22 1/2, 22 1/2	22.9
"	Steel	21, 20, 22 1/2, 22 1/2, 20, 20 1/2, 24, 20, 20, 22 1/2	21.3
"	Al	22 1/2, 20, 21, 21, 24, 22 1/2, 22 1/2, 20, 24, 21	21.9
MOX-2B	Bare	16, 15, 15, --, 17 1/2, 17 1/2, 15, 15, 17, 17	16.1
"	Steel	16, 16, 16, 21, 15, 17 1/2, 17 1/2, 19, 17 1/2, 17 1/2	17.3
"	Al	15, 16, 16, 17 1/2, 12 1/2, 17 1/2, 17 1/2, 17 1/2, 16, 17 1/2	16.3

5.4 Table IV: Free-Air 5" NT-C

Nominal HE wt.: 1.0 lb.

Range: Halifax

<u>HE</u>	<u>Case</u>	<u>5" N T-C Readings</u>	<u>Average</u>
Torpex-2	Bare	7, 5, 5, 6, 6, 7, 9, 7, 7, 7	6.6
"	Steel	3, 2, 4, 3, 4, 4, 4, 4, 4, 5	3.7
"	Al	5, 3, 4, 5, 4, 5, 5, 3, 4, 7	4.5
HBX-6	Bare	6, 7, 5, 7, 7, 5, 6, 6, 8, 6	6.3
"	Steel	3, 3, 3, 3, 4, 4, 4, 4, 4, 4	3.6
"	Al	4, 5, 5, 6, 5, 4, 6, 5, 6, 6	5.2
SSB/KS	Bare	8, 6, 5, 5, 5, 5, 7, 6, 6, 7	6.0
"	Steel	3, 3, 4, 4, 4, 4, 4, 3, 3, 4	3.6
"	Al	6, 4, 5, 6, 6, 5, 5, 5, 6, 4	5.2
HBX-1	Bare	6, 5, 4, 5, 5, 7, 8, 5, 6, 6	5.7
"	Steel	3, 3, 3, 3, 3, 5, 4, 3, 4, 6	3.7
"	Al	3, 4, 5, 4, 4, 5, 5, 4, 7, 6	4.7
FRX	Bare	5, 4, 5, 5, 4, 4, 4, 6, 5, 5	4.7
"	Steel	4, 2, 3, 3, 3, 3, 3, 3, 5, 4	3.3
"	Al	3, 3, 4, 4, 3, 3, 4, 3, 4, 5	3.6
TNT	Bare	5, 4, 3, 5, 4, 4, 5, 6, 6, 5	4.7
"	Steel	2, 2, 3, 4, 2, 2, 3, 2, 3, 4	2.7
"	Al	2, 2, 6, 3, 2, 2, 4, 2, 4, 4	3.1
MOX-2B	Bare	3, 2, 2, 3, 4, 3, 3, 3, 3, 3	2.9
"	Steel	2, 2, 2, 2, 2, 2, 2, 3, 3, 4	2.4
"	Al	3, 2, 2, 2, 2, 3, 3, 3, 3, 3	2.6

Confidential

11.

6.0 INITIAL DISTRIBUTION LIST

Addressee

Copy No.

**Commanding Officer
Picatinny Arsenal
Dover, N. J.
Attn: Mr. S. M. Adelman
Samuel Feltman Ammunition Laboratory**

1-12 incl.

**Contracting Officer
Boston Ordnance District
Army Base
Boston 10, Mass.**

13, 14

Confidential